anywhere within a cell, geographical separation is not feasible. The separation distances that would be required are discussed below.

The required geographical separation distance between an LMDS subscriber receiver and an FSS earth station can be calculated as a function of the location of the FSS earth station relative to the mainbeam of the LMDS subscriber antenna, as was done in the Sarnoff Report for interference between LMDS and point-to-point relay systems. For an LMDS subscriber receiving antenna located at the edge of its service area, an FSS earth station in its backlobe (i.e. about 48° to 180° away from the antennas mainbeam direction), would need to be at least 2.9 km (1.8 miles) away from the subscriber. Near the LMDS antenna mainbeam, the earth station would have to be over the horizon from the subscriber, a distance larger than a single LMDS cell, so as not to cause interference into the subscriber receiver. A single LMDS subscriber receiver at the edge of its service area would prohibit the location of an earth station almost anywhere within its cell. Since, by the nature of the LMDS, a large number of subscribers are expected in each cell, the area covered by an LMDS cell would be virtually unusable by FSS earth stations.

While VSAT terminals are likely to be the most ubiquitous of FSS earth stations operating in the FSS Ka-band allocations, there are also expected to be larger earth stations with higher power spectral densities. These earth stations would be even more difficult to coordinate with intensive band use by LMDS systems.

Sharing between LMDS Transmitters and FSS Satellite Receivers

FSS satellites operating in the 27.5 - 29.5 GHz band will receive emissions from terrestrial LMDS transmitters. Based on the 3.5 million square mile area of the continental United States and a cell area of about 20 square miles, up to 175,000 LMDS transmitters could be operating on the same frequency. A geostationary satellite antenna beam covering the continental United States would receive the emissions from every operating LMDS transmitter.

Depending upon the assumptions made, interference from the LMDS systems would enter various geostationary FSS satellite receivers 2 to 14 dB below the receiver thermal noise level based on conservative assumptions. Uncertainties include the average gain of the LMDS antennas towards the satellite and the number and geographical distribution of LMDS transmitters. An appropriate criteria for interference would appear to be a level 10 dB below the thermal noise. Thus, there is a potential for a fully developed LMDS to cause unacceptable interference to a fixed satellite. The number of LMDS transmitters might need to be limited to maintain interference at an acceptable level.

Finally, it should be noted that, according to parameters given in the Sarnoff Report, the power delivered to the antenna of an LMDS system would be 12 dBW. This would appear to exceed the limit given by No. 2508 and No. 2511 of the International Radio Regulations. The reason for this regulation is to protect receiving space stations from terrestrial system sidelobe and backlobe interference. In the instant case, the interference level in the space station receiver depends upon the number of terrestrial stations within the coverage area of the satellite and the average of their antenna gains in the direction of the satellite. The application of this regulation is particularly important with respect to the LMDS which uses low gain, low discrimination antennas and plans to deploy tens of thousands of transmitters.

It should also be noted that CCIR Recommendation 406, which provides the basis for the limits in RR2508, states in considering (d) "that it is highly desirable that radio-relay systems should employ highly directional antennas." Clearly, the LMDS would not satisfy this condition.

While the design of an LMDS system is up to the operator of the system, if an LMDS system is implemented that is later found to have insufficient margin, any increase in the system power to obtain additional margin would cause a further increase in the interference noise level in the satellite receivers operating in the band, further exacerbating a difficult sharing situation.

Sharing between LMDS and FSS Power Control Beacon Downlinks

For many FSS systems, uplink power control systems will be required to achieve uplink availability and performance standards. To accomplish this, the uplink earth station will monitor a narrow-band downlink beacon from the satellite. WARC-92 allocated two 1 MHz wide band, 27.500-27.501 GHz and 29.999-30.000 GHz for this purpose. The effective use of the lower half of the 27.5 - 30.0 GHz FSS band depends on beacons operating at 27.500-27.502 GHz. RR882A restricts the eirp of such beacons towards adjacent geostationary satellites to 10 dBW. This essentially limits the power delivered to the antenna to about 10 to 15 dBW. Power control beacon signals could be expected from every FSS satellite in orbit.

The effect of FSS beacon signals on co-frequency LMDS receivers will vary depending upon the number of satellite beacon downlinks into the LMDS service area, the satellite eirp and the bandwidth of the LMDS signals. While the effect on an 18 MHz FM-TV signal receiver would probably be minimal, the effect on a co-frequency narrow band signal could be considerably greater.

In addition, it should be noted that ACTS has a propagation beacon downlink at 27.505 GHz, operating in the secondary allocation provided for this purpose. While the ACTS beacon should have no effect on LMDS systems using 18 MHz FM-TV signals, it could affect narrower signals, on the order of 56 kHz, which are described in the Sarnoff Report for the "future development of secondary services."

Frequency coordination could also be required between FSS power control beacon receiving earth stations and LMDS transmitters. The receiving earth station, however, will not have any flexibility in frequency selection because the primary allocation for the service is only 1 MHz wide and the satellite will have only one beacon signal. They will also have very little flexibility with regard to location because they will be operating in conjunction with an uplink earth station that must be coordinated with systems operating in a different portion of Ka-band. For these reasons, FSS power control beacon earth stations would have extreme difficulty in changing any of its operational parameters as part of a coordination. Accordingly, the Commission would have to require that LMDS transmitters protect FSS power control beacon earth stations operating in accordance with RR882A.

Sharing Between LMDS and Fixed Systems

It is also worth noting that the Sarnoff Report, starting on page 80, gives an analysis of interference from an LMDS base station transmitter to a point-to-point service receiver. The results, yielding a required separation between the LMDS transmitter and fixed service receiver of 1.34 miles for an off-axis separation angle of 5°, are based on rather optimistic assumptions for the fixed service antenna gain. Following the method presented in that report, but applying standard CCIR antenna radiation diagrams for the fixed service, it can easily be demonstrated that the required separation is 1.4 miles based using the backlobe gain of the fixed station antenna. This means that for a cell with radius 3.9 miles, no fixed service antenna could be located within 1.4 miles of the center. This distance is consistent with the required separation distance between LMDS stations and FSS earth stations described above. If the fixed service antenna is pointed within 48° of the LMDS base station, antenna coupling between the two antennas would increase, necessitating an increase in the required separation distance.

The Sarnoff Report touches on interference to LMDS only briefly saying that the LMDS system could take the steps necessary to ensure compatibility with fixed point-to-point systems by installing passive repeaters. There would still exist a region around each LMDS subscriber within which a point-to-point system could not be located due to interference entering the backlobe of the subscriber. The addition of passive repeaters would also create additional propagation paths between LMDS receivers and satellite and point-to-point transmitters further complicating the coordination process for all systems.

VI. THE PROPOSED LMDS ALLOCATION WOULD HAVE A SEVERE IMPACT ON THE FUTURE OF THE U.S. SATELLITE INDUSTRY AS IT WOULD EFFECTIVELY PREEMPT FUTURE FSS USE OF Ka-BAND

Although satellite use of the Ka-band is still in its early stages of development, such use, as explained in Section III, is expected to grow considerably in the years ahead. The ACTS program will go a long way toward nurturing this development. As explained below, however, if the Commission adopts the proposals contained in the Notice, the development of satellite-delivered services at Ka-band will almost certainly be stymied.

Although the FSS would retain co-primary status in the 28 GHz band, once an LMDS system is licensed in a given metropolitan area, it will have "first-in-time" interference rights vis-a-vis any future FSS stations. Under normal circumstances, this would simply mean that the FSS licensee would be obligated to ensure that its earth station does not cause harmful interference to the LMDS system. As demonstrated in the preceding section, however, this will be a virtually impossible task for the FSS licensee because coordination between FSS uplinks and LMDS receivers does not appear to be feasible. Consequently, the would-be FSS user will be effectively foreclosed from using the band anywhere near the general vicinity of the LMDS system. In many cases, this will mean not using a satellite service at all because, as noted above, the urban areas that are desirable for LMDS are the same areas that are desirable for FSS, particularly for VSAT networks.

There is a substantial likelihood that this scenario will come to pass in the vast majority of metropolitan areas around the country because many of the anticipated commercial satellite operations in the Ka-band will not evolve until after the ACTS experiments have been completed. Indeed, testing the Ka-band waters for the commercial space industry is one of the primary purposes of the ACTS program. If the proposed LMDS allocation is adopted, LMDS systems will in all likelihood be licensed throughout the country during the ACTS experimental period. The 971 LMDS applications that were filed even prior to issuance of the Notice for cities ranging in size from New York City to Cheyenne, Wyoming, certainly suggest that this will be the case. If this occurs, then, in the short run, LMDS operators would have priority rights over ACTS earth stations (assuming they are limited to experimental status), and, in the long run, they will have priority status over subsequently licensed FSS earth stations, thereby foreclosing FSS operations in the Ka-band in virtually every metropolitan area in the country.[24]

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24 Moreover, from an international standpoint, the LMDS proposal threatens the ability of Canada and Mexico to use the 27.5-29.5 GHz band in areas near the U.S. border.

The geographic scope of the problem would not be as severe were it not for the fact that, from a frequency standpoint, the proposed LMDS service would effectively preclude the FSS from using 80 percent of the 27.5-30.0 GHz uplink band. However, as noted above, the impact goes even beyond that because the remaining 500 MHz of the uplink band will likely be reallocated to the mobile-satellite service on a co-primary basis in ET Docket No. 92-191. While NASA supports that proposal, it must be recognized that the practical effect will be to reduce the spectrum available for FSS at Ka-band. In addition, the loss of the 27.5-29.5 GHz portion of the uplink would orphan the corresponding portion of the downlink band at 17.7-20.2 GHz as a result of the imbalance between the paired uplink and downlink bands.

In short, while the FSS would, in theory, retain co-primary status under the proposed rules, it would, as a practical matter, lose its allocation at 27.5-29.5 GHz (as well as 17.7-19.7 GHz).

From a public interest standpoint, the loss of this allocation would have at least four negative consequences. First, it would mean that the demand for both domestic and international Ka-band satellite services described in Section III will not be satisfied. Second, the approximately $1 billion taxpayer investment in ACTS will have been for naught. Third, not only would LMDS be blocking the public's access to FSS services, by occupying the entire 27.5-29.5 GHz band, it would be preempting competition from Ka-band satellite systems which could provide some of the same types of services that LMDS systems could provide. Finally, the space services sector of the economy would suffer as a result of the lost business opportunities for U.S. satellite and earth station manufacturers. Europe and Japan are already beginning to exploit Ka-band satellite technology. If LMDS is allowed to halt the development of such technology in the U.S. just when major strides are about to be made through the launching of ACTS, then, for virtually the first time, the U.S. will be abdicating its leadership position in a segment of the satellite industry.

VII. THE COMMISSION DID NOT ADEQUATELY CONSIDER THE IMPACT OF THE PROPOSED LMDS ALLOCATION ON THE FSS AND, HAD IT DONE SO, NASA BELIEVES IT WOULD HAVE FOUND THAT THE NEEDS OF THE FSS OUTWEIGH THE COMPARATIVELY WEAK CASE FOR ALLOCATING ADDITIONAL SPECTRUM FOR VIDEO DISTRIBUTION

Although, ostensibly, LMDS would be a multi-purpose service, including video, voice and data capabilities, there can be little doubt that it will be first and foremost a medium for transmitting video entertainment programming.[25] The Commission acknowledges this in paragraph 14 of the Notice, and tentatively concludes that the use of the 28 GHz band for the provision of video programming is in the public interest because it will infuse additional competition into the video services marketplace. Notice at para. 16. As explained below, although NASA questions the need to allocate yet additional scarce spectrum for the distribution of video programming, its primary disagreement with the Commission's tentative conclusion relates to the context in which it was made.

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[25] See Suite 12 Group Petition for Rulemaking at 4 n. 8 (stating that video applications are the primary focus of the Petition) and at 11 (stating that "one of the principal benefits of reallocating the 28 GHz band for LMDS will be to help ensure that the public's unsatisfied demand for multichannel video distribution service can be met.")

As an initial matter, NASA disagrees with the premise that increasing competition in the video programming market is a sufficient justification for allocating this spectrum to LMDS. To the contrary, it is precisely because there is already extensive competition in the video services marketplace that there is no need for LMDS. Among the many sources of video programming are television broadcasting, cable television, wireless cable (which, the Commission notes, was recently allocated additional spectrum), direct broadcast satellites, SMATV systems, video cassettes and, in the not-too-distant future, it is likely that telephone companies as well as cable TV companies will provide video programming services via fiber-to-the home or fiber-to-the-curb. When this occurs, there will be literally hundreds of video channels available to the American people. Moreover, LMDS cannot distinguish itself by virtue of providing interactive video services because the Commission allocated spectrum for a new Interactive Video and Data Service last year and it is highly likely that such services will eventually be provided on a widespread basis by cable TV companies, wireless cable operators and telephone companies.

The Commission notes that the additional competition from LMDS would further its goal of using the marketplace to regulate the price, type, quality and quantity of video services. In NASA's view, the amount of competition from LMDS systems would hardly be a panacea to rising cable television rates. Competition from other video service providers did not act as a restraint on cable prices in the past and there is no reason to expect that LMDS systems would have any appreciable impact either. Indeed, it was because marketplace regulation of cable TV was not working that prompted the shift toward re-regulation of the cable industry.

It is also important to recognize that the technical limitations inherent in providing a terrestrial point-to-multipoint service in the 28 GHz band raise serious questions about the technical and economic viability of LMDS in many areas of the country.[26] From an economic standpoint, the propagation characteristics of the 28 GHz band and power levels at which equipment in this band can reasonably be expected to operate are such that the coverage area of each transmitter will be too limited to serve sparsely populated small towns and rural communities. Such areas will be served more economically by satellite-based services, such as DBS. Yet, to the extent there is any unsatisfied demand for video services, as claimed by Suite 12 Group, it is precisely in those rural areas where such demand is likely to exist.[27] The only areas where LMDS could conceivably be economically viable are urban areas and it is in those very same densely populated areas where there is the least need for such service because of the large number of alternative sources of video programming.

This is not to say that allowing video service providers to use spectrum that will otherwise lie fallow cannot be in the public interest. Were this

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26 See supra Section IV for a discussion of some of the technical questions regarding the viability of LMDS.

27 Moreover, since LMDS would not be providing any competition to cable systems and other video service providers in non-urban areas, the Commission's purported competition rationale for allocating spectrum for LMDS is largely misplaced.

the case here, NASA would have no disagreement with the Commission's efforts to maximize use of the spectrum. However, the Commission's tentative conclusion regarding the 28 GHz band was based on an incorrect premise, namely, the 28 GHz band not being utilized. As explained above, it is anticipated that there will be considerable use of the 28 GHz band made by the FSS. In fact, in footnote 2 of the Notice, the Commission takes note of ACTS as well as Motorola Satellite Communications, Inc.'s application to use the band for gateway/control links to support its proposed Iridium low-earth orbit satellite system. Inexplicably, however, the Commission ignores the FSS in the section of the Notice in which it discusses the issue of whether allocating the 28 GHz band for LMDS is in the public interest. See Notice at paras. 14-19. It mentions the FSS only in paragraphs 22-24 in the context of coordination. Obviously, however, such a discussion presupposes that it is in the public interest for LMDS to be sharing the band with the FSS in the first place.

Essentially, this is the basis for NASA's contention that the Commission did not make its public interest determination regarding LMDS in the proper context. The Commission should have weighed the perceived benefits of LMDS against the needs of the FSS. If the Commission believed that it did not have sufficient information concerning FSS plans for this band in order to make such a determination, then it should have issued a notice of inquiry before proceeding to rulemaking. In NASA's view, had the Commission weighed such information against the comparatively weak case for allocating additional spectrum for video distribution, it would not have come to tentative conclusion that it does in the Notice. Fortunately, as discussed below, it is not too late to give full consideration to this information before making a decision that will have long-lasting implications for the Ka-band and the FSS.

VIII. THE COMMISSION SHOULD DEFER FOR FIVE YEARS A DECISION ON WHETHER TO ALLOCATE SPECTRUM IN THE 28 GHz BAND FOR LMDS SO THAT IT CAN PROPERLY WEIGH THE IMPACT ON THE FIXED-SATELLITE SERVICE IN LIGHT OF THE RESULTS OF THE ACTS EXPERIMENTS

Although ACTS is licensed to NASA, one of its primary purposes is to yield information on the technical and economic viability of high risk, advanced Ka-band satellite technology for the commercial sector. These experiments will take place over the course of the next four years. In NASA's view, the most prudent course for the Commission to take with respect to the future of the 28 GHz band is to monitor the ACTS experiments during that time period and to evaluate the full range of options for the 28 GHz band in light of the results of those experiments.

If the Commission applies a balancing test here, it can only conclude that delay will best serve the public interest. On the one hand, it is difficult to see the harm in delaying the introduction of yet another video programming outlet to the market. On the other hand, failing to delay further consideration of an LMDS allocation at Ka-band will result in substantial and irreparable harm to the public because hasty action will, to a large extent, waste the approximately $1 billion taxpayer investment in ACTS. Once an allocation decision is made, the spectrum will, as a practical matter, be forever lost or at least lost for the foreseeable future. Thus, it behooves the Commission to err on the side of caution.

In fact, a five year delay would prove useful not only in terms of providing the Commission with critical information about the future of satellite technology in the Ka-band, but also about the future of video distribution to the home. In the wake of the Commission's video dialtone decision and Judge Greene's lifting of the MFJ information services restriction, the next few years will be very telling in terms of telephone company entry into this field. If, as expected, telephone companies begin to make significant strides toward establishing fiber optic links to the home or to the curb, the need for LMDS will be even more questionable and its ability to survive economically will be highly dubious.

In short, in NASA's opinion, it would not be in the public interest to deprive the nation of the potential benefits in new communications services, lower communications costs, and creation of new jobs that introduction of ACTS technologies can foster before a thorough evaluation of the lessons to be learned during the ACTS experiments program can take place.

IX. CONCLUSION

WHEREFORE, the foregoing considered, NASA urges the Commission to delay further consideration of the proposed 28 GHz band allocation for LMDS for five years pending the results of the ACTS experiments.

Respectfully submitted,

By:
Charles T. Force
Associate Administrator for
Space Communications
National Aeronautics and Space
Administration

March 16, 1993

ACTS EXPERIMENTERS

Appendix A

Planned ACTS Participants

No.	Principal Investigator Organization	Terminal Type[1]	Location
1	National Communications System	T-1 VSAT	Reston, VA Pasadena, CA
		AMT	Los Angles, CA
2	NTIA Institute for Telecommunication Sciences	T-1 VSAT	Boulder, CO
3	U.S. Army Institute for Research in Management Information, Communications, and Computer Sciences, Information Systems Engineering Command	T-1 VSAT	Atlanta, GA
4	U.S. Army Space Command	T-1 VSAT	Ft. Monmouth, NJ Bedford, MA Ft. Gordon, GA Ft. Leavenworth, KS Colorado Springs, CO
5	Jet Propulsion Laboratory	AMT	Los Angeles, CA
		AERO	Between Chicago, Cleveland and Washington
		LET	Cleveland, OH
6	NASA Johnson Space Center	T-1 VSAT	Houston, TX
7	New Mexico State University	T-1 VSAT	Las Cruces, NM Apache Point Observatory, NM
8	Public Broadcasting Service	HDR	Alexandria, VA
9	Georgetown University	T-1 VSAT	Washington, DC Bogotá, Colombia
10	COMSAT Laboratories	T-1 VSAT Propagation	Clarksburg, MD

Planned ACTS Participants (Cont.)

No.	Principal Investigator Organization	Terminal Type[1]	Location
11	Mayo Foundation	T-1 VSAT	Rochester, MN Scottsdale, AZ Eau Claire, WI Red Lake, MN Decorah, IA Flagstaff, AZ
		HDR	Rochester, MN
12	Dataflow Systems	T-1 VSAT	To Be Determined
13	Orion Satellite	User Provided	To Be Determined
14	George Washington University	HDR	Washington, DC
15	MITRE	T-1 VSAT	Reston, VA
16	Motorola	T-1 VSAT HDR	Chandler, AZ
17	New Jersey Institute of Technology	T-1 VSAT	East Windsor, NJ
18	Weber State University	USAT	Los Angeles, CA
		LET	Cleveland, OH
19	American Express	T-1 VSAT	Phoenix, AZ Mexico City, Mexico
20	Ohio University	T-1 VSAT	Columbus, OH Athens, OH
21	U.S. Army Topographic Engineering Center	T-1 VSAT	Ft. Belvoir, VA Ft. Monmouth, NJ WSMR, NM
22	COMSAT World Systems	T-1 VSAT	Clarksburg, MD
23	Pacific Space Center	T-1 VSAT HDR	Honolulu, HI

Planned ACTS Participants (Cont.)

No.	Principal Investigator Organization	Terminal Type[1]	Location
24	Maryland Center for Commercial Development of Space	T-1 VSAT	Clarksburg, MD
		HDR	TO BE DETERMINED
25	NSF Division of Polar Programs	T-1 VSAT	Palmer Station, Antarctica
26	Florida Center for Commercial Development of Space	LET	Cleveland, OH
27	University of British Columbia	Propagation	Vancouver, B.C.
28	Colorado State University	Propagation	Ft. Collins, CO
29	University of Alaska	Propagation	Fairbanks, AK
30	Stanford Telecomm., Inc	Propagation	White Sands, NM
31	University of Oklahoma	Propagation	Norman, OK
32	University of South Florida	Propagation	Tampa, FL
33	Johns Hopkins University, Applied Physics Laboratory, and University of Texas, Austin	Propagation	Various locations in MD and AK
		LET	Cleveland, Ohio

1. T-1 VSAT = Very Small Aperture Terminal with a T-1 Rate.
   AMT = ACTS Mobile Terminal
   AERO = ACTS Aeronautical Mobile Terminal
   LET = Link Evaluation Terminal
   HDR = High Data Rate
   Propagation = Propagation Receive Only Terminal
   USAT = Ultra Small Antenna Terminal

Potential ACTS Participants

No.	Principal Investigator Organization	Terminal Type[1]	Location
1	Ohio Super Computer Center	HDR	Columbus, Ohio
2	Lockheed	T-1 VSAT	Kennedy Space Center, FL
3	Harris	T-1 VSAT	Melbourne, FL
4	Rockwell	AERO	Between Chicago, Cleveland, and Washington
5	IDB	AERO	Between Chicago, Cleveland, and Washington
6	University of Washington	T-1 VSAT	Seattle, WA
7	GE	T-1 VSAT	East Windsor, NJ
8	AmeriTech/Ohio Bell	T-1 VSAT	Cleveland, OH
9	VIACOM	USAT	To Be Determined
10	NASA Ames	T-1 VSAT HDR	Palo Alto, CA
11	Norris Communications	T-1 VSAT	White Sands, NM
		HDR	Rochester, MN
12	BBN	HDR	Cambridge, MA
13	Rome Labs	HDR	Rome, NY
14	GTE	HDR	Needham, MA
15	US Sprint	HDR	Kansas City, MS
16	NASA GSFC	HDR T-1 VSAT	Greenbelt, MD
17	University of Kansas	HDR	Lawrence, KS

1. T-1 VSAT = Very Small Aperture Terminal with a T-1 Rate.
   AERO = ACTS Aeronautical Mobile Terminal
   HDR = High Data Rate
   USAT = Ultra Small Antenna Terminal

ARC Professional Services Group

C^{3}I Systems Division

Appendix B

Sharing Between Local Multipoint Distribution Service and Other services in the 27.5 - 29.5 GHz band

Atlantic Research Corporation
a subsidiary of Sequa Corporation

Appendix B

Sharing Between Local Multipoint Distribution Service and Other services in the 27.5 - 29.5 GHz band

1. Introduction

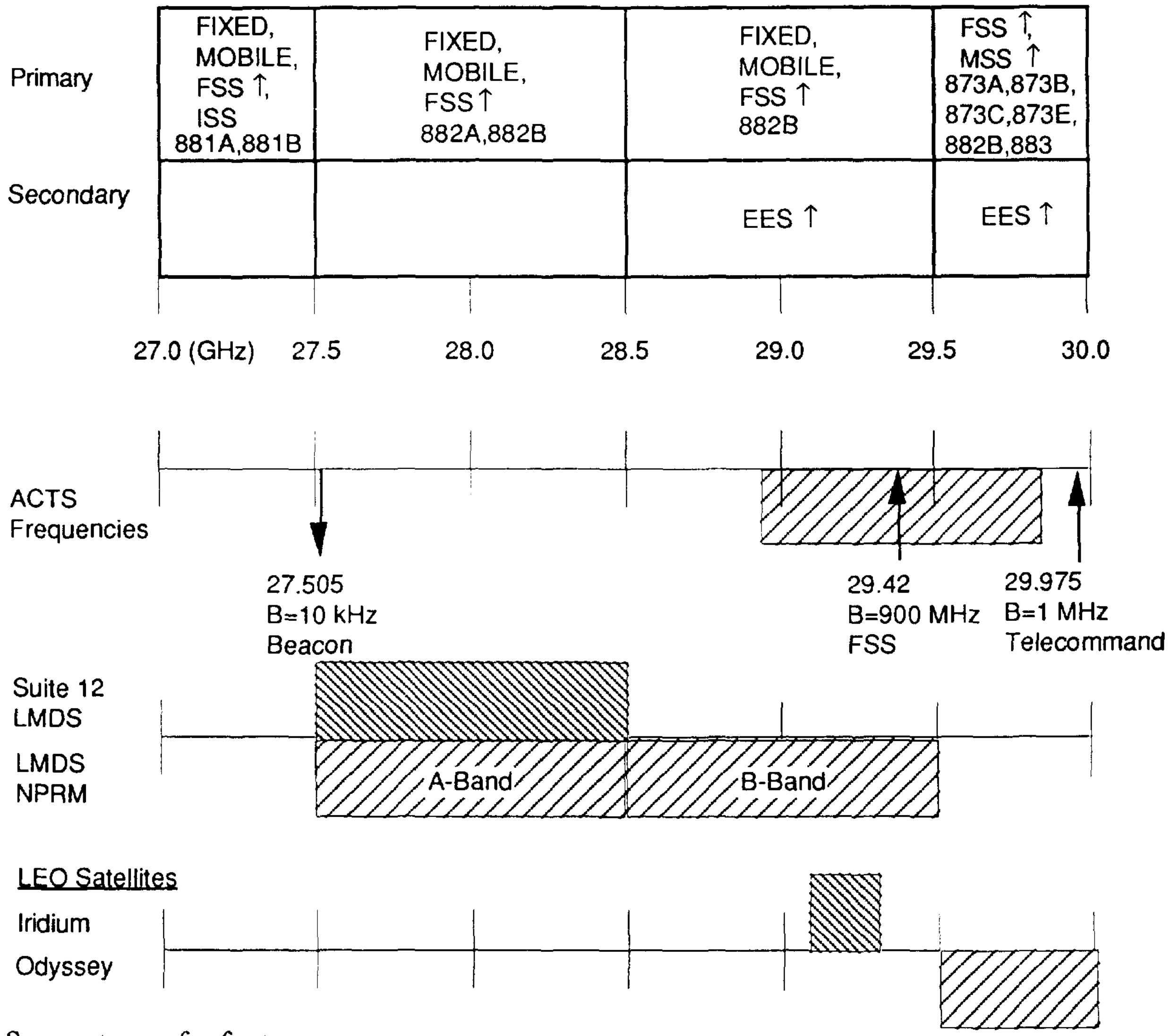
The FCC Notice of Proposed Rulemaking (NPRM) on the Local Multipoint Distribution Service (LMDS) proposes rules for a new service to be implemented in the 27.5 - 29.5 GHz band. This band is shared with the fixed-satellite service (FSS) which, in this band, could include VSATs, high data rate FSS uplinks, FSS feeder links to geostationary satellites and feeder links to low-Earth orbit (LEO) satellites. Figures 1-1 shows the ITU Region 2 allocations for the 27.5 - 30.0 frequency band. This also includes the bands used by NASA's ACTS satellite, the bands proposed in the NPRM for the LMDS and those bands currently proposed for use by feeder links to LEO satellites. Additional FSS satellites and the bands used or proposed are contained in Figure 3-1, where characteristics of those links are given.

2. LMDS System Characteristics

A detailed description of an LMDS system is provided by a report entitled "Suite 12 System Analysis for Video Distribution and Secondary Services" by the David Sarnoff Research Center, dated 17 September 1991 (the Sarnoff report). The Sarnoff report describes an LMDS system that it states would provide high quality multi-channel video signals and two-way audio, video, and data transmission through a network of distribution cells. The system would be able to provide 49 video channels and compete with fiber optic cable and handle future advances such as high definition television and digital communications. Since this system makes use of the air ways there would be no need to run coaxial cable or fiber optic lines.

The Sarnoff report describes a multicellular system designed to operate in the 27.5-29.5 GHz range. One GHz of this range is used to transmit 49 channels. The channels from a single base station have a single polarization. Each channel is made up of a frequency modulated signal occupying a 20 MHz channel. Two-way communication channels may, in the future be inserted between the video channels and have opposite polarity. An omni-directional in azimuth antenna is placed inside the cell. Each cell is 6 to 12 miles in diameter. Repeaters and reflectors are used to reach spots that are obstructed. These cells are arranged in a multicellular configuration to provide nearly uniform coverage throughout a given area. Adjacent cells are crossed polarized—vertical and horizontal, to provide polarization discrimination between cells. Narrow beams provide a high degree of rejection to interference from neighboring cells. The report claims that its combination of frequency modulation, antenna polarization, space diversity, and frequency diversity makes the system use the frequency spectrum efficiently.

Transmission and general system characteristics are provided in Figure 2-1. These are the LMDS characteristics used in this report. Figure 2-2 provides a description of the layout and polarization scheme of an LMDS system.



See next page for footnotes

Figure 1-1 International Allocations (Region 2)

882A: Additional allocation: the bands 27.500 - 27.501 GHz and 29.999 - 30.000 GHz are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis for the beacon transmissions intended for up link power control.
Such space-to-Earth transmissions shall not exceed an equivalent isotropically radiated power (e.i.r.p.) of +10 dBW in the direction of adjacent satellites on the geostationary-satellite orbit. In the band 27.500 - 27.501 GHz, such space-to-Earth transmissions shall not produce a power flux-density in excess of the values specified in No. 2578 on the Earth's surface.

882B: Additional allocation: the band 27.501 - 29.999 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a secondary basis for beacon transmissions intended for up link power control.

883: Additional allocation: in Afghanistan, Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei Darussalam, Cameroon, China, the Congo, the Republic of Korea, Egypt, the United Arab Emirates, Ethiopia, Guinea, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kenya, Kuwait, Lebanon, Malaysia, Mali, Morocco, Mauritania, Nepal, Niger, Pakistan, Qatar, Syria, Singapore, Somalia, Sudan, Sri Lanka, Chad and Thailand, the band 29.5 - 31 GHz is also allocated to the fixed and mobile services on a secondary basis. The power limits specified in Nos. 2505 and 2508 shall apply.

873A: In order to facilitate interregional coordination between networks in the mobile-satellite and fixed-satellite services, carriers in the mobile-satellite service that are most susceptible to interference shall, to the extent practicable, be located in the higher parts of the bands 19.7 - 20.2 GHz and 29.5 - 30 GHz.

873B: In the bands 19.7 - 20.2 GHz and 29.5 - 30 GHz in Region 2, and in the bands 20.1 - 20.2 GHz and 29.9 - 30 GHz in Regions 1 and 3, networks which are both in the fixed-satellite service and in the mobile-satellite service may include links between earth stations at specified or unspecified points or while in motion, through one or more satellites for point-to-point and point-to-multipoint communications.

873C: In the bands 19.7 - 20.2 GHz and 29.5 - 30 GHz, the provisions of No. 953 do not apply with respect to the mobile-satellite service.

873E: The use of the bands 19.7 - 20.1 GHz and 29.5 - 29.9 GHz by the mobile-satellite service in Region 2 is limited to satellite networks which are both in the fixed-satellite service and in the mobile-satellite service as described in No. 873B.

881A: Use of the 25.25 - 27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

881B: Space services using non-geostationary satellites operating in the inter-satellite service in the band 27 - 27.5 GHz are exempt from the provisions of No. 2613.

Figure 1-1 International Allocations (Region 2) (Continued)